

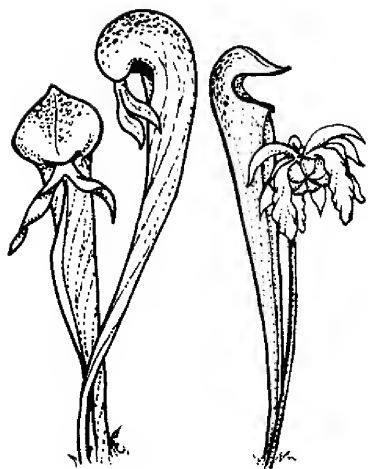
CARNIVOROUS PLANT NEWSLETTER

Journal of the International Carnivorous Plant Society

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Front Cover: Colorized SEM images of terminal discs and raised heads of *Drosera glanduligera* snap-tentacles. Image by the Plant Biomechanics Group Freiburg and I. & S. Hartmeyer. Article on page 4.

Back Cover: The cultivar *Dionaea* 'Ginormous'. Photo by Damon Collingsworth. Article on page 25.

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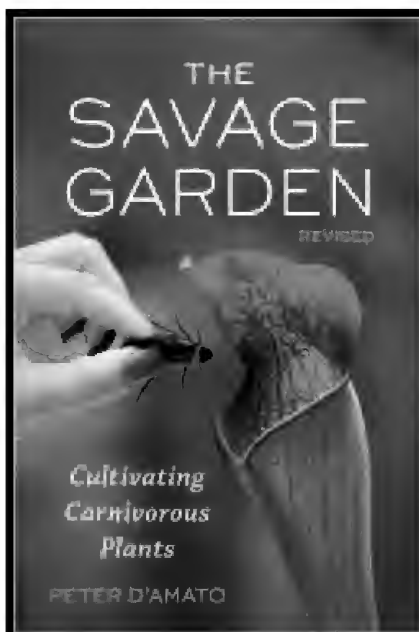
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INTRODUCING RICHARD NUNN—NEW ICPS BOARD MEMBER

Richard is a Senior Executive in the Australian Financial Services Industry. His studies have been commerce related and he holds a Bachelor of Business from the University of South Australia, a Graduate Diploma in Economics from the University of Adelaide, a Diploma from the Australian Institute of Company Directors and is a graduate of the Advanced Management Program from the Harvard Business School. His interest in nature began at an early age, growing up in the Adelaide Hills surrounded by natural bushland that contained a diverse array of native plants, animals and insects, many of which found their way into jars and aquariums in his room. His fascination with Carnivorous Plants started at age 12 and has been a passionate hobby for over 30 years. Although a keen cultivator of Carnivorous Plants, the focus of this interest has shifted over the past decade to capturing these amazing plants through the lens of a camera in their natural habitat. Richard is co-author of the recently published book, *Australian Carnivorous Plants*, and has contributed articles to both the Australasian and Victorian CP Societies. Over the past decade he has undertaken over 80 field trips to view and photograph CPs in Australia, Asia, and the USA.



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CATAPULTS INTO A DEADLY TRAP: THE UNIQUE PREY CAPTURE MECHANISM OF *DROSERA GLANDULIGERA*

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Keywords: catapult-flypaper-trap, cultivation, *Drosera glanduligera*, functional morphology, plant biomechanics, snap-tentacles.

Introduction

Active trapping mechanisms constitute some of the most spectacular examples for how carnivorous plants catch their prey (Darwin 1875; Lloyd 1942; Juniper *et al.* 1989). Recently, we showed that the Pimpernel Sundew (*Drosera glanduligera* Lehm.) possesses active combined catapult-flypaper-traps which work with a sophisticated two-step mechanism (Poppinga *et al.* 2012): after mechanical stimulation, elongated marginal snap-tentacles at the trap periphery rapidly fling the prey, often with its dorsal side first, onto sticky glue-tentacles on the leaf blade within less than 1/10 second. Subsequently, stimulated mechanically by the impact, slower glue-tentacles lift the prey into a deeply concave leaf-center where digestion takes place. The snap-tentacles have been analyzed in respect to their kinematics, functional morphology and anatomy, and our observations confirm a complex adaptation to carnivory. From the very beginning we intended to accompany our research with informative documentaries (Hartmeyer & Hartmeyer 2012a,b) and to provide this additional article to the readers of the CPN. It features a brief summary of the main results, some extended background information, further original morphological observations, and interpretations (surely featuring issues to discuss) as well as a detailed description of how to cultivate this sophisticated carnivorous plant.

Background Story

Remarkably, the rapid snap-tentacle motion of the Pimpernel Sundew has not been noticed for a long time, ranging for more than 150 years from the species description (Lehmann 1844) until the end of the last millennium. Even in the otherwise comprehensive benchmark books on Australian carnivorous plants published more than one hundred years after the first species description, this mechanism was not mentioned (Erickson 1968; Lowrie 1989). The same holds for the article of Seine & Barthlott (1993) who provided a detailed comparative anatomical survey of the apical tentacle parts of numerous *Drosera* species and described *D. glanduligera* to possess bilaterally symmetric tentacles with a raised head, a feature that is unique in the genus. The first person to report on snap-tentacle action

was Richard Davion who published two important field reports in “Flytrap News”, the newsletter of the Carnivorous Plant Society of New South Wales (Davion 1995; 1999), mentioning that “... *the dry pads* [of the Pimpinel Sundew] *are quite able to flick ants into the center of the traps.*” He noticed the fast snap-tentacle motion of *D. glanduligera* already in 1974 at Cannington Swamp near Perth as a 9-year-old boy (pers. comm.). In 2003, Davion contacted Irmgard and Siegfried Hartmeyer and provided seeds with the request to examine and confirm the rapid motion, which was successfully accomplished and published in *Das Taublatt*, the journal of the German CPS (GFP) (Hartmeyer & Hartmeyer 2005). In addition, a video documentary (Hartmeyer & Hartmeyer 2006) with detailed macro-shots was released and presented at the 2008 ICPS conference in Frostburg, constituting a comparative morphology of the multifold elongated marginal tentacles in the genus *Drosera* and also including first speed measurements (see also a contribution in McPherson 2008). An upgraded article in the CPN on the snap-tentacle phenomenon followed in 2010 (Hartmeyer & Hartmeyer 2010). The fast tentacle motion performed by a *Drosera* species drew the attention of plant biologists who work on “rapid plants” on the otherwise rather inconspicuous Pimpinel Sundew. However, Davion’s assertion that prey can be thrown into the leaf-center became meanwhile adopted by several authors (Gibson & Waller 2009; Bourke & Nunn 2012), but was never confirmed by prey capture experiments or scientifically conducted observations in the field. In January 2012 we decided to bridge this knowledge gap by experimentally feeding cultivated *D. glanduligera* plants to record the trapping motion and furthermore to conduct morphological and anatomical investigations.

Cultivation of *Drosera glanduligera*

The Pimpinel Sundew is an annual winter grower with a wide distribution range across the southern regions of Australia (Erickson 1968). Therefore it needs cool nights but warm and bright days to thrive well. After cultivating the plants for almost ten years in the Northern Hemisphere, our observations show that the germination of *D. glanduligera* seeds is triggered when the night temperature drops significantly below 8°-10°C for approximately 3-7 days after the seeds have been sown on a standard peat-sand-mixture (partly containing also pumice gravel or Perlite) in June, and remain on the wet soil in full sunlight during the summer. A reduced “hot season” may avoid germination in time and cause a delay for a whole year (see below). Due to decreasing night temperatures in autumn, germination usually starts in October in the south-western region of Germany. In 2012, the first seeds sown in early June germinated after only three cool nights (4°-5°C) in late September. We do not use any additional treatments to improve the germination such as smoked water, gibberellic acid, or other methods and substances, respectively. For the experiments described, approximately 300 seeds were sown in mid-July 2010, from which about 200 germinated with a surprising extreme delay in October 2011, and from which approximately 150 plants matured.

In order to thrive well, the temperature after germination has to remain only slightly above 0°C at night until the beginning of March. During the daytime, plenty of light and temperatures of up to 15°-25°C are necessary. In January 2012, the temperature for our test plants ranged between 0.8° and 27°C. An electric frost protection unit avoided a cooling down below the freezing point, and during the day we achieved ideal conditions with a sunny south-western exposure position, combined with a 400 watt metal halide lamp. If the night temperature rises above 8°C before March, premature flowering is triggered, resulting in early plant death and a reduced seed production.

Apart from this, another factor proved to be extremely important for the plants: in addition to the correct light and temperature conditions the plants need constant nutrition supply from the very beginning. Only then the seedlings metamorphose, in the first 4-6 weeks of initial growth, from the juvenile

phase with simple sticky traps to the adult phase with catapult-trap leaves. *Collembola* (springtails) most likely constitute the main natural prey for *D. glanduligera* and other Australian sundew species (Verbeek & Boasson 1993; Watson *et al.* 1982). Ideally, if one has living springtails in the plant pots and soil they will be successfully caught and digested (Hartmeyer & Hartmeyer 2010). Otherwise, the feeding necessary for *D. glanduligera* is quite time-consuming and takes place in several consecutive phases, depending on the age and size of the plants. We use standard fish food flakes which are comminuted between the fingers. The smallest pieces are picked up using a forceps (best with magnifier glass) to feed the plants leaf by leaf. This procedure is performed for plants of about 2-5 mm in diameter. In the next phase, when the leaves are about 3 mm in diameter, we feed them with fruit-flies that are commercially available in garden centers or pet shops. The flies are cut into appropriate pieces (considering the small leaves) using a scalpel. This provides ideal nutrition to the plants as early as possible, avoids over-feeding them, and reduces the risk of mold formation. Later, when the leaves are about 5-6 mm in diameter, there is no major risk in feeding even 2-3 fruit-flies at a time per leaf. New leaves are reproduced every 3-4 days until the end of the growing season. Therefore, the feeding should be repeated about twice per week to achieve permanent growth.

Flowering, Seed Production, and Seed Morphology

With the above mentioned conditions, flowering was observed to take place from early March until late April 2012 (Fig. 1a). When the flowers are open, night temperature may rise to 10°-12°C and the day temperature may exceed even 30°C without any visible deterioration of the plants. Providing as much light as possible is highly recommended.

In cultivation the plants are mostly self-pollinating and multiple seed-pods will emerge on the inflorescence stalk, while new flowers are still produced on the stalk apex (Fig. 1b). In May 2012 we observed most of the seed-pods to ripen. At the same time, the rosettes started to become brownish and the plants died back within a few days. By end of May to early June 2012 we harvested the seeds.

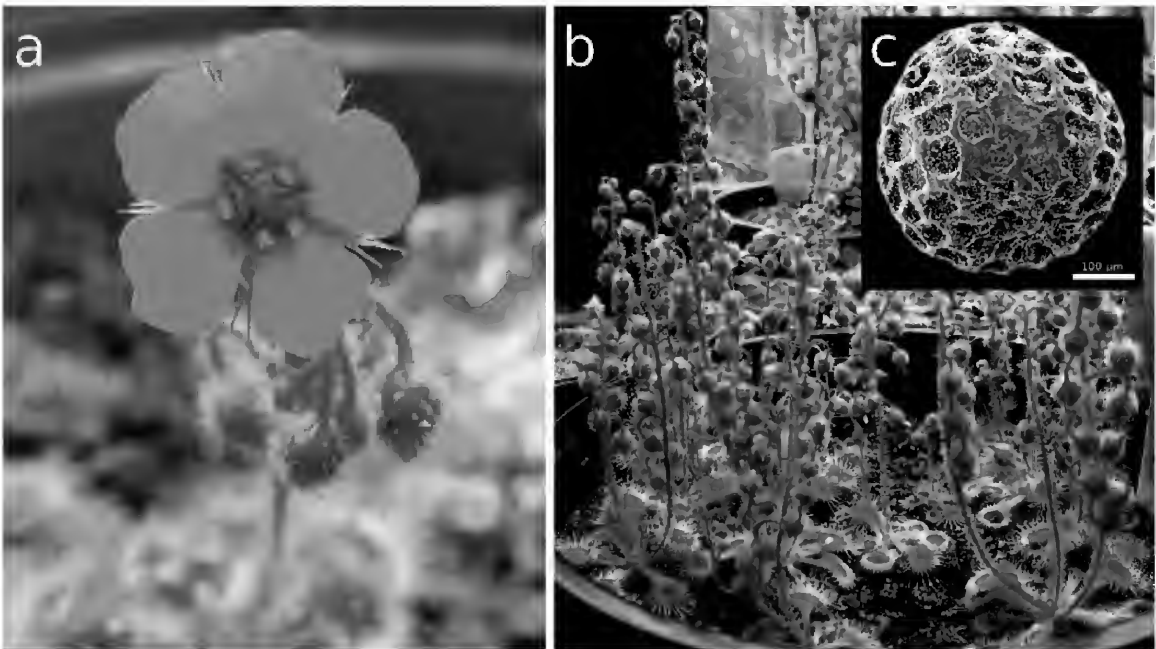


Figure 1: *Drosera glanduligera* in cultivation. a) Flower. b) Adult plants producing numerous seed capsules on the inflorescence stalks. c) Scanning electron microscopy image of a seed grain featuring concave testa cells and epicuticular wax crystalloids.

However, it is actually quite tedious to free them from dried plant matter, sticking to the still gluey seed pods. Each plant can produce several hundred seeds. Transport by wind or ejection caused by rain are, in our opinion, the most probable means by which the Pimpernel Sundew seeds are being dispersed, but studies from the field are missing so far. The spherical seeds are approximately 400 μm in diameter and are characterized by a surface with concave testa cells (Fig. 1c). As concave cells are very rarely found in fresh plant material but regularly on dry seed surfaces (Barthlott & Hunt 2000; Koch *et al.* 2008), the inward deflection of the outer epidermis wall is most probably caused by water loss and shrinkage. Moreover, epicuticular wax crystalloids of the granule and rodlet types, typified according to Barthlott *et al.* (1998), are uniformly distributed on the testa.

Prey Capture Experiments

For our prey capture experiments we used common fruit-flies (*Drosophila melanogaster*). Due to their commercial availability and easy care they were perfect specimens for our tests, although they are unlikely to be the natural prey. The intention was to test if snap-tentacles can fling prey animals (Davion 1995, 1999), *i.e.* to elucidate their role in prey capture, under laboratory experimental conditions. It is still up to future studies to record snap-tentacle behavior in the plant's habitat with natural prey (springtails, ants) and to identify its importance for the plant. For a detailed description of "Materials and Methods" and an outlook for future studies we refer to our original article (Poppinga *et al.* 2012).

We placed flies next to the plants and recorded trapping action with a HDV camcorder and a high-speed camera with a recording speed of 2000 fps. The videos obtained (Hartmeyer & Hartmeyer 2012a,b; Poppinga *et al.* 2012) clearly show that the rapid catapult function of snap-tentacles is combined with a slower "band-conveyor" mechanism carried out by the more centrally arranged sticky glue-tentacles. First, the prey is lifted and thrown onto the trap leaf by snap-tentacles which, after mechanical stimulation by the animal, rapidly bend towards the leaf center within 75 milliseconds. The prey now is in a very disadvantageous position, because in most captures observed it was attached with its dorsal side first to the glue-tentacles, and we hypothesize that this mechanism also accounts for effectively immobilizing the prey. Owing to the mechanical impact, glue-tentacles also start to bend towards the trap center, but much slower, lasting approximately two minutes (which still is quite a fast *Drosera* tentacle movement). Hereby prey is drawn into the deeply concave leaf-center where digestion takes place, probably well-protected from kleptoparasites as reported from *Drosera erythrorhiza* (Watson *et al.* 1982). Unlike in many other sundews (Darwin 1875; Lloyd 1942; Williams 1976; Juniper *et al.* 1989), we did not observe leaf blade movement after capture of prey. Such a sophisticated, combined two-step trapping mechanism is unique in the plant kingdom, and we propose to use the term "active catapult-flypaper-trap" exclusively for *Drosera glanduligera*. A passive catapult-pitfall-trap system, enabled by a semi-slippery trap surface and initiated by the impact force of raindrops, has recently been described for the *Nepenthes gracilis* pitcher plant (Bauer *et al.* 2012), constituting a further example of a "hybrid trapping strategy" (Rice 2007).

Tentacle Motion Analysis

How can snap-tentacles move so fast? Active plant movements (*e.g.*, the leaflet folding of the famous sensitive *Mimosa pudica*) are often enabled by changes in turgor pressure (cell sap pressure) in antagonistically acting cellular tissues called pulvini (Braam 2005). Such systems are based on a displacement of water through a porous medium, the pulvinus tissue, and hence are actuated hydraulically. The duration of the fluid flow, and therefore the duration of the whole movement, depends on the

thickness of the tissue the fluid has to pass. To move fast, the moving organ hence has to be small (as the hydraulically actuated *Mimosa pulvinus* (Volkov *et al.* 2010)), or must rely on a simple but effective “trick”: like in a bow, stored elastic energy can be used to generate extremely fast motions “on demand” (Skotheim & Mahadevan 2005; Dumais & Forterre 2012). For example, the Venus Flytrap features large and fast traps (snapping lasts ~100 ms) and hence uses a buckling instability to perform their action, comparable with a rubber-popper-toy (Forterre *et al.* 2005). Other examples are bladderworts. Although their trapdoors are quite small, their movement is also too rapid to be actuated purely hydraulically when performing their “ultra-fast” opening motion in less than a millisecond (Vincent *et al.* 2011). The fastest movements known in plants are achieved by explosive fracture and are not reversible, *e.g.*, the bursting fruits of the Sandbox Tree (*Hura crepitans*) (Swaine & Beer 1977).

Having seen the snap-tentacle bending motion fully time resolved for the first time we also first believed that an elastic instability is involved. More precisely, as it is a long filiform structure that changes its curvature in short time (75 ms) we assumed a similar mechanism as present in certain bicycle reflector bands that one strikes against the wrist to make it curl. Here, a long, flat and relatively stiff band with an initial transverse concave curvature of the reflector surface abruptly switches this curvature to convex (snap-buckling) after mechanical disturbance, which entails the fast rolling-in of the whole band (that has the intrinsic mechanical property to curl). Surprisingly, we found that the transverse axis of the tentacle does not undergo a sudden geometrical change, and that there are no noticeable anatomical features (*e.g.*, thickened cell walls) that could take part in storing elastic energy (see also “Tentacle Morphology and Anatomy”). As described in our original study, it can be calculated that snap-tentacles theoretically are small enough to be actuated completely hydraulically. Hence, we interpret the fast motion to be due to a change in turgor pressure in antagonizing tissue layers, but further experiments, especially in physiology, are needed for verification. As outlined in detail in the original article (Poppinga *et al.* 2012), snap-tentacles function only once which is presumably due to collapsing epidermal cells.

Tentacle Morphology and Anatomy

The spoon-shaped trap leaves of *D. glanduligera* each carry a multitude of glue-tentacles, and in adult plants about 12-18 catapulting snap-tentacles that extend horizontally (in the plane of the lamina). Mechanical stimuli on the heads of both tentacle types entail bending motions, as described in the above section. The sticky tentacles show a bauplan (body plan) typical for *Drosera* tentacles by consisting of a cylindrical stalk, emerging almost vertically from the leaf lamina, and a more or less spherical, mucus-secreting head. The region of stalk-head-connection, where the stalk is thinnest, is generally considered as the mechanoreceptor region (Williams 1976). Although we recorded the glue-tentacle motion, we did not investigate their anatomy in detail.

Excised snap-tentacles were analyzed with a light microscope and a scanning electron microscope. Five µm semi-thin transverse and longitudinal sections with toluidine blue staining were analyzed with the light microscope. For full details of materials and methods we refer to our original article (Poppinga *et al.* 2012). As detailed by Seine & Barthlott (1993), the snap-tentacles are bilaterally symmetric. The stalk is flattened with a so-called terminal disc, somewhat resembling a human hand, that carries the mucus-free head (Fig. 2 and Front Cover). The flattened stalk most presumably accounts for the uniplanar, circular bending movement the snap-tentacles perform towards the trap leaf, whereas cylindrical glue tentacles can bend in more than one plane. The snap-tentacle’s head-stalk-connection is very thin and most likely plays an important role in perception of mechanical stimuli (Fig. 2). Laterally on the stalk, small sessile glands of unknown function are visible (Fig. 3a,b). The snap-tentacle stalk consists of outer epidermal cells, parenchymatous inner cells (Fig. 3c) and vascular tissue. The latter consists of

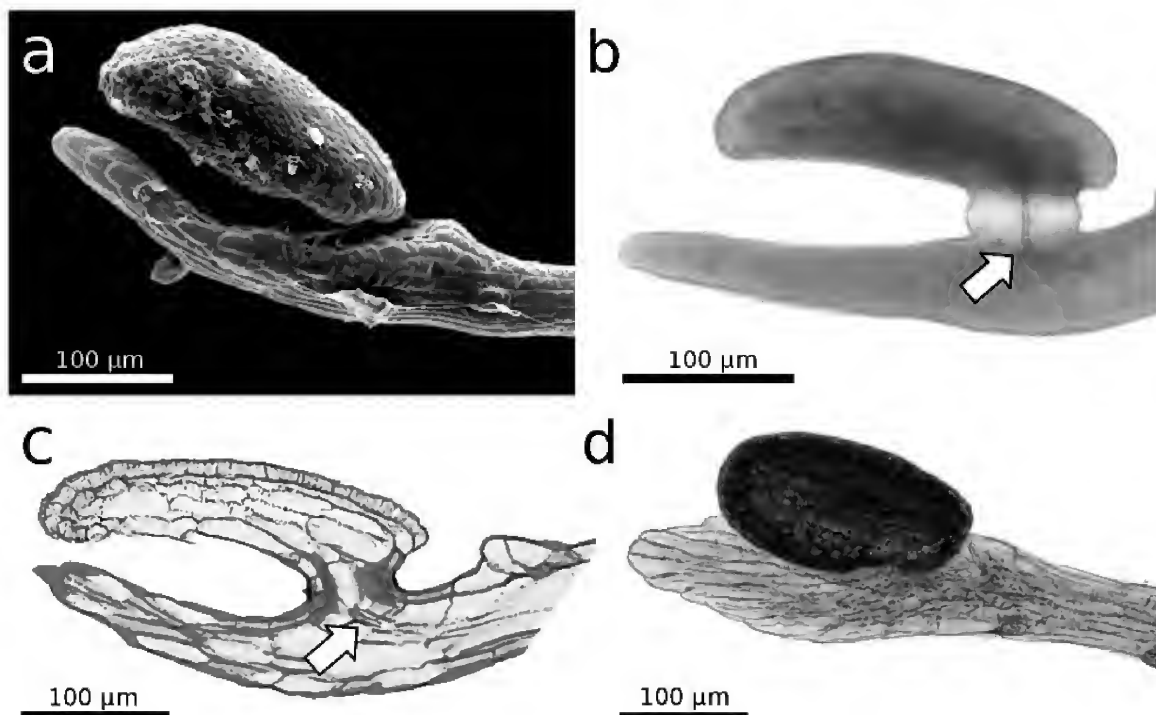


Figure 2: The snap-tentacle head is raised above the stalk's terminal disc, which somewhat resembles a human hand. a) Scanning electron microscopy image. b,c,d) Light microscopy images. b,c) The conducting strand is well visible (arrows). c) 5 µm semi-thin longitudinal section, stained with toluidine blue. The thin stalk-head-connection most presumably plays an important role in reception of mechanical stimuli. d) The tentacle head is stained with toluidine blue.

a tracheid system (Fig. 4a), including a branched xylem in the head (see also Williams & Pickard 1974; Williams 1976) that is connected to a single conducting strand in the center of the stalk (Fig. 2b,c). Epidermal and parenchymatous cells are elongated, of variable diameters, and do not feature significantly thickened cell walls, as already described in the section “Tentacle Motion Analysis” (Fig. 3c).

As far as we could observe, the conducting strand in the stalk is disconnected from the leaf lamina by ending close to the hinge-zone (Fig. 4a). The hinge zone is situated near the tentacle base and depicts the zone where snap-tentacles bend during the fast motion (Hartmeyer & Hartmeyer 2010; Poppinga *et al.* 2012). Interestingly, here also exists a constriction with a layer of cells that appear to be somewhat pre-cut and thereby constitute a “fault zone” (Fig. 4b). When a slight lateral mechanical force is applied to a snap-tentacle, it will break at this region (Fig. 4b). Although the snap-tentacle bending is extremely fast and most presumably generates comparably high compressive and tension forces on the cellular tissues, there exists, hence, also a mechanical weak point (or predetermined breaking point) in this region. It can be speculated that the conducting strand adds mechanical stiffness to the apical snap-tentacle part, which was observed to remain straight during the motion. On the other hand, such a strand would impede the fast bending motion of the hinge-zone. A detailed investigation of the isolated tracheid system and of the “breaking point” is a matter for future studies.

Transitional Stages of Tentacle Morphology during Ontogeny

Morphological characteristics of trap leaves and their tentacles in different ontogenetic stages ranging from seedlings to adult plants were observed with a ProScope HR USB-microscope (Bodelin Tech-

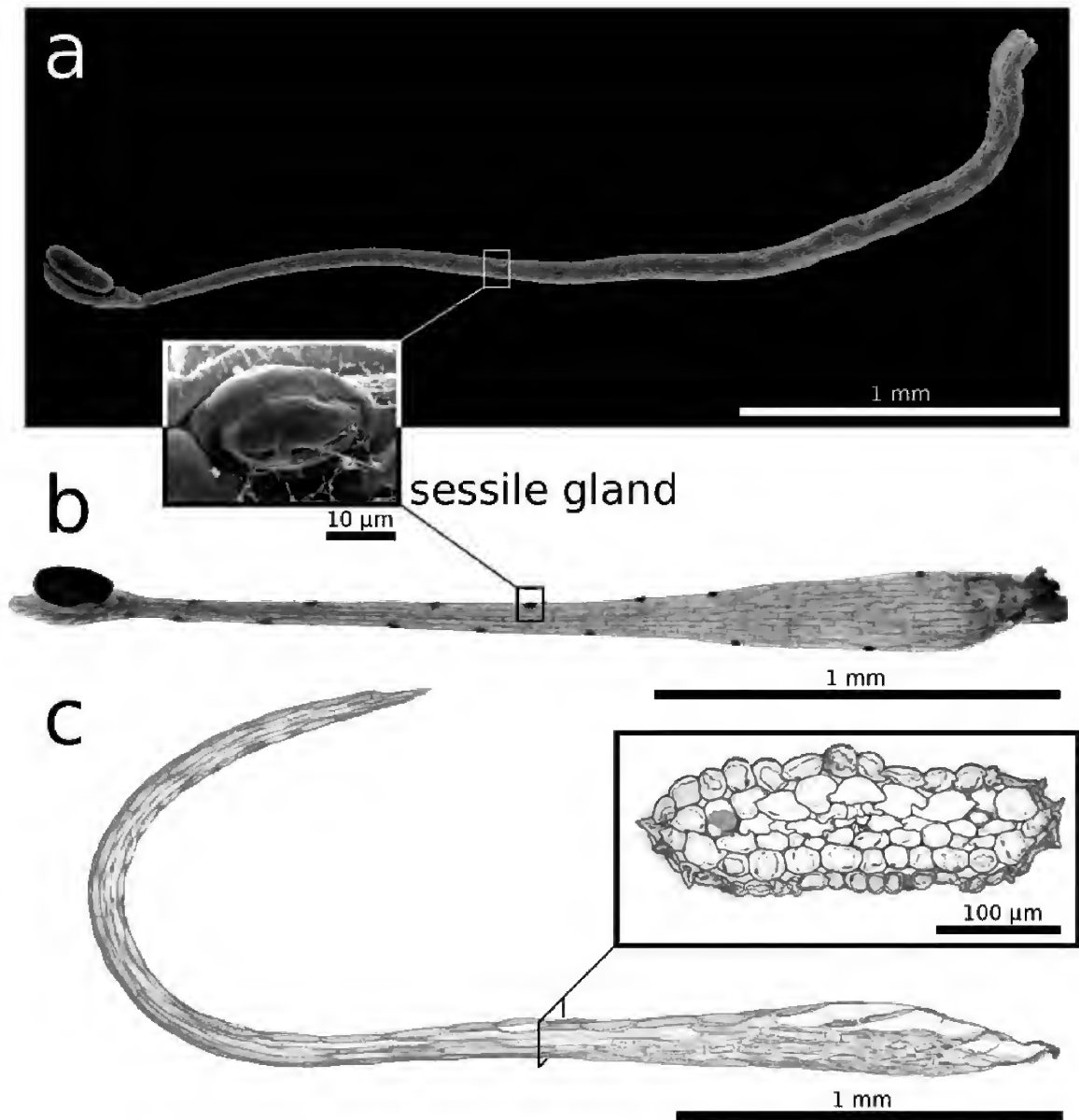


Figure 3: Snap-tentacle morphology and anatomy. a) Scanning electron microscopy image. b) Light microscopy image. a, b) Sessile glands on the stalk. c) 5 μm semi-thin longitudinal section, the insert shows a transverse section, of the snap-tentacle stalk, both stained with toluidine blue.

nologies, Oregon, USA), using a 200-fold magnification lens. “Modern” sundew species that feature snap-tentacles typically produce two cotyledons which are only exceptionally carnivorous, as in *D. ultramafica* where they possess a few sticky tentacles (pers. observ.). Additionally to the typical glue-tentacles on the lamina, all first trap leaves of these species possess three to five elongated, mucus-free and bilaterally symmetrical snap-tentacles that extend in the plane of the lamina. Hence, all these seedlings possess fully developed snap-tentacles from the very beginning, which are able to bend (most presumably by turgor-movement) in a time range between approximately five seconds to a few minutes, depending on the species and the surrounding temperature. The appearance of different snap-tentacles in the genus *Drosera* has been examined during the last decade in more than 100 different species (Hartmeyer & Hartmeyer 2010).

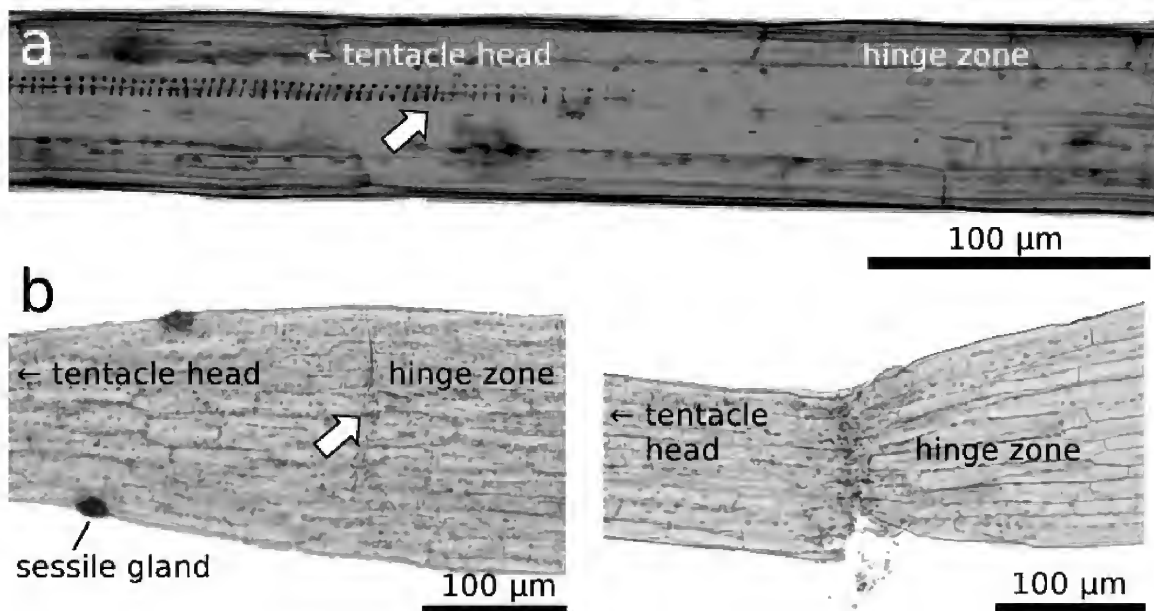


Figure 4: Light microscopy images of the transition zone close to the hinge region, which is characterized by a) a disconnected conducting strand (arrow, for better visibility structures here were enhanced by adjustment of brightness and contrast), and b) by a predetermined breaking region with a layer of cells that appear as a pre-cut “fault zone” (arrow) that leads to tentacle rupture when a lateral force is applied.

Drosera glanduligera seeds germinate without developing visible cotyledons; the first leaf already is a fully functional sticky trap growing in an upright direction from the seed, but without any snap-tentacles. The following three to four leaf generations show intermediate developmental stages during which the elongated marginal tentacles significantly change their morphology. The more or less spherical (symmetric), mucus-producing head becomes replaced by the glue-free, bilaterally symmetric, raised head as described above. As the hinge-zone of the stalk becomes more and more pronounced, the continuous conducting strand (Fig. 5) becomes disconnected from the lamina during the transitional stages just at the hinge region (Fig. 4). Also, the cavity for digestion in the center of the leaf becomes more and more distinctive. In cultivation, the first fully functional combined catapult-flypaper-traps emerge about six weeks after germination. Although the first catapulting tentacles still look very tender, they are nevertheless already capable of flinging springtails effectively onto the leaf-center (pers. observ.).

Discussion

A raised tentacle head, a disconnected conducting strand and a preformed tentacle “breaking region”, a unique hinge-zone, and a rapid motion comparable with the trapping speeds of *Aldrovanda* and *Dionaea* (Ashida 1934; Forterre *et al.* 2005; Poppinga & Joyeux 2011) distinguish the catapulting snap-tentacles of *D. glanduligera* clearly from all other (much slower) snap-tentacles found in other sundew species, such as *D. burmannii* (Hartmeyer & Hartmeyer 2010) or *D. rotundifolia* (Darwin 1875). The combined catapult-flypaper-trap comprises a combination of 12-18 one-shot devices (the marginal catapults) with a subsequent “band-conveyor” consisting of sticky tentacles. Glue-tentacles are both able to draw larger prey into the center, and to return to their initial position after the delivery of the prey in order to wait for the next victim becoming catapulted by snap-tentacles. We hypothesize that catapulting snap-tentacles enable successful capture (and retention) of comparably large prey animals that otherwise could escape from glue-only traps.



Figure 5: Digitally enlarged USB-microscope image of a glue-tentacle in an early stage of *D. glanduligera* development, which possess an obviously fully functional conducting strand. They later become replaced by catapult-snap-tentacles in which the strand is disconnected (see Fig. 4).

We hypothesize that the capture of larger prey animals occurs only occasionally and that the capture of smaller animals, such as springtails, being probably the main prey animals (see also “Cultivation of *Drosera glanduligera*”), occurs much more frequently. *Collembola* are almost ubiquitous and find ideal life conditions in leaf litter (Fjellberg 1998), which most probably is also true for the prey species *Hypogastrura vernalis* identified by Watson *et al.* (1982). Additionally, *Collembola* are reported to be caught in high numbers by other co-occurring Australian *Drosera* species (Watson *et al.* 1982; Verbeek & Boasson 1993). These micro-arthropods might well be attracted by chemical volatiles that come along with wilting and wilted leaves, and we hypothesize that this might be the case not only for *D. glanduligera*, but also for many other carnivorous plants. Especially in perennial species growing as ground rosettes, the accumulation of dead plant material could facilitate an effective attraction. The Pimpernel Sundew has perfected its traps by the outstretched

catapulting tentacles. Another speculation is raised by the question about the function of the sessile glands on the snap-tentacle stalks (Fig. 3a,b; 4b). Perhaps these glands also take an active part in prey attraction by emitting scents. Recently, attraction by sex-specific volatiles was reported for moss where the allured micro-arthropods act as sperm dispersers (Rosenstiel *et al.* 2012). This finding highlights how *Collembola* and other arthropod groups might be chemically attracted. Perhaps, such mechanisms have evolved independently more frequently and for more different purposes in plants than thought before.

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BRIEF INFORMATION ABOUT THE SPECIES STATUS OF
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Keywords: *Utricularia cornigera*, hybrid, heterosis, apomixis

Abstract: The carnivorous plant *Utricularia cornigera* Studnička was described in 2009, but authorities of the International Carnivorous Plant Society published an opinion that it is not a true species, but only a natural hybrid of *U. reniformis* and *U. nelumbifolia*. The role of heterosis is discussed, because *U. cornigera* is much larger than both theoretical parents. Seedlings, the very characteristic feature of bladderworts (*Utricularia*), are different in all the bladderworts described, that is, in the named species and in artificial hybrids of *U. nelumbifolia* and *U. reniformis*. No support for the hypothesis supposing a hybrid origin of *U. cornigera* was found.

Introduction

Recently a hypothesis appeared that *Utricularia cornigera* Studnička could be a hybrid of *U. nelumbifolia* Gardn. × *U. reniformis* St.Hil. (Schlauer 2011; Fleischmann 2012). Consequentially, the new species was rejected from the Carnivorous Plant Database (Schlauer 2011). Nevertheless it was accepted in the International Plant Name Index (IPNI 2005). This article presents the results of new experiments with artificial crossings of both theoretical parents proposed by the authors.

The manner of germination and specifically the appearance of the seedlings are crucial phenomena in the life strategy of bladderworts. In the *Utricularia* species from the section *Iperua* there are two different ways of germination: either by floating seedlings (e.g. *U. cornigera*, *U. nelumbifolia*), or by terrestrial seedlings (e.g. *U. geminiloba*, *U. nephrophylla*, and the true *U. reniformis*).

The difference was described and pictured as a very important diacritical attribute of *U. cornigera* as compared with *U. reniformis* (Studnička 2009). As mentioned in the previous paper, *U. reniformis* does not have whorl-shaped seedlings and it cannot germinate in water, but *U. cornigera* germinates in water. The floating whorl-shaped seedlings of *U. cornigera* are rather similar to the also whorl-shaped seedlings of the Brazilian *U. nelumbifolia* and the Venezuelan *U. humboldtii* Schomb. These species can use phytotermes within the leaf rosettes of certain host plants to germinate (Taylor 1989; Studnička 2011).

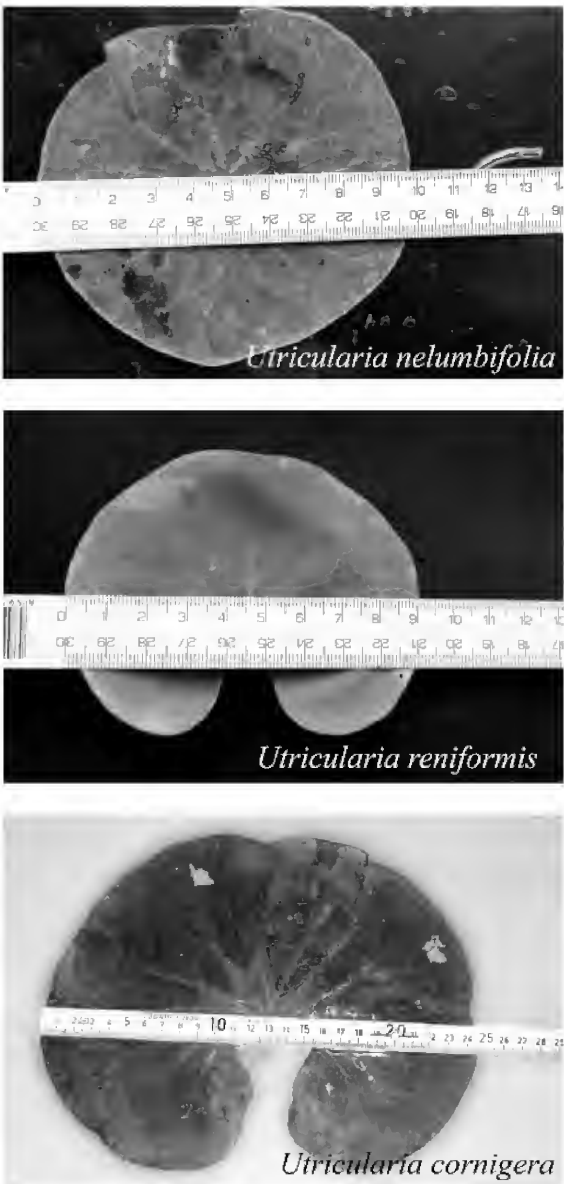
Methods

Cultivated plants were used for manual hybridization, which was carried out during July and August 2012 in Liberec Botanic Gardens. Specific identity of *U. reniformis* is granted by a previous study made using the same material (Studnička 2009). Specific identity of *U. nelumbifolia* is clear because the stoloniferous plants distributed in European botanic gardens are of natural origin. Numerous fresh seeds (the whole content of at least 2 full seed capsules of each species or hybrid) were put into water in a glass and cultivated in a greenhouse. The seeds of *U. reniformis*, which could not germinate in such conditions, were also placed on a wet soil mix of peat and dried *Sphagnum* moss 1:1 and were also cultivated in the greenhouse. Just the soil surface provides suitable conditions for *U. reniformis* to germinate.

The seedlings of *U. reniformis*, *U. nelumbifolia*, *U. nelumbifolia* × *U. reniformis*, and *U. reniformis* × *U. nelumbifolia* were documented by photographs taken using a Pentax 35 mm macro lens. The floating hybrid seedlings were compared with the seedlings of *U. cornigera* formerly used to describe the species (Studnička 2009).

Possible heterosis was evaluated according to the maximal size of the leaf blades found. The bladderwort *U. cornigera* was measured in natural localities as well as in cultivated specimens, both giant (Studnička 2009). The species *U. nelumbifolia* found thanks to F. Rivadavia near Teresópolis in Serra dos Órgãos was much smaller than the specimens cultivated in Liberec Botanic Gardens, which is why I present a measurement of a cultivated plant here. The leaf of the flowering cultivated specimen of *U. reniformis* used in this research was also measured and compared with the largest leaf found in natural conditions (cf. Studnička 2009).

Results



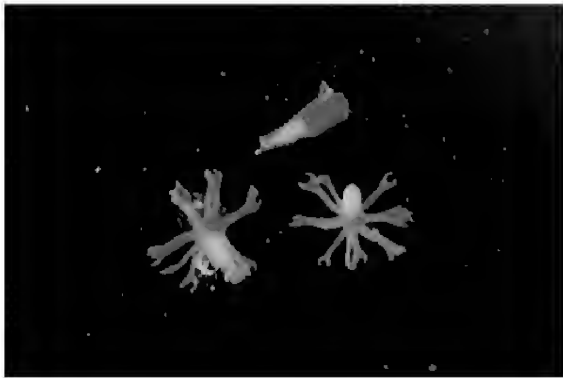
Figures 1-3: Leaves of luxurious specimens of cultivated bladderworts. The scale is in centimeters.

The question is whether the prospective hybrid theoretically resulting in *U. cornigera* would be an F1 generation or a descendant of multiple breeding. To assess this problem measurements of the largest known leaves in all three species in question are needed. I can give these dimensions: *U. cornigera* 24.4 × 20.7 cm (cultivated specimen), but also up to 17.5 × 13.0 cm in natural conditions; *U. reniformis* 9.2 × 7.5 cm (cultivated specimen), but even 10.5 × 8.5 cm in natural conditions; *U. nelumbifolia* 9.9 × 9.6 cm (cultivated specimen), but distinctly smaller specimens were seen in natural conditions. The preserved leaf of *U. cornigera* photographed in this article is located in the PRC herbarium; the leaves of the other species are found in Liberec Botanic Gardens (www.botaniliberec.cz). It was documented that the leaf laminas of the theoretical parental species are both about half the size of those of *U. cornigera* (Fig. 1-3). If *U. nelumbifolia* and *U. reniformis* were the parents of *U. cornigera*, the giant size of its leaf lamina would be a sign of heterosis.

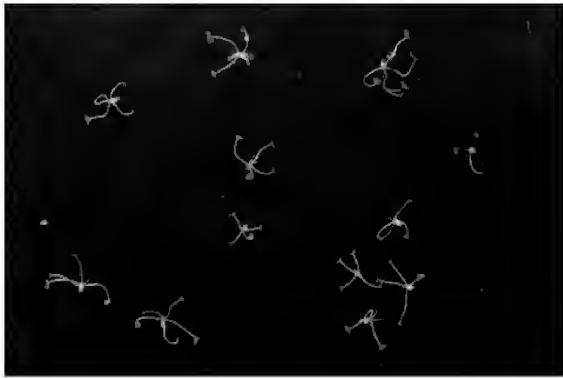
The seedlings of all three species are very characteristic. Are the juvenile hybrids of *U. nelumbifolia* × *U. reniformis* (and conversely) similar to *U. cornigera*? The results of crossing experiments are documented below (Fig. 4-8).

Discussion

The bladderwort *U. cornigera* is much more vigorous than both *U. nelumbifolia* and *U. reni-*



Figures 4-5: Floating seedlings of *Utricularia nelumbifolia* (left) and terrestrial seedlings of *U. reniformis* (right). These theoretical parents of *U. cornigera* were crossed artificially. (See the following figures.)



Figures 6-7: Seedlings of the hybrid *Utricularia nelumbifolia* ♀ × *U. reniformis* with 4-5 leaf primordia (left) and of the hybrid *U. reniformis* ♀ × *U. nelumbifolia* with 3-4 leaf primordia (right).



Figure 8: Seedlings of *Utricularia cornigera* with 6-8 leaf primordia are dissimilar to the hybrids pictured above.

formis. Therefore, the heterosis effect in the F1 crossbred generation should be noted, if *U. cornigera* were to be considered as a hybrid. The heterosis effect is, however, unsustainable in subsequent generations. The gigantism in *U. cornigera* (considered a hybrid) would be stable solely by two prerequisites: 1. It is a primary hybrid; 2. It propagates only asexually.

U. cornigera produces viable seeds, but they could theoretically be a result of apomixis. Nevertheless, research of seedlings made by crossbreeding experiments between *U. nelumbifolia* and *U. reniformis* indicates lower numbers of leaf

primordia in these hybrids in comparison with *U. cornigera*. This is clear evidence that the seedlings of *U. cornigera* cannot be an apomictic derivative of the hybrids *U. nelumbifolia* × *U. reniformis* or *U. reniformis* × *U. nelumbifolia*. Experience with a cultivated *U. cornigera* indicates that manual pollination is necessary to obtain seeds and seedlings. That is also a sign of normal sexual propagation. As the aforementioned prerequisites are not fulfilled, the idea that *U. cornigera* originated as a hybrid is not supported. According to this preliminary result, *U. cornigera* arose due to reproductive isolation, like other endemic plants restricted to the same area, rather than from a hybrid origin. The future study of

traps, and or fertility/sterility in mature hybrids would also be interesting corroboration of the species status of *U. cornigera*.

Conclusions

1. The seedlings originating from both crossings of *U. nelumbifolia* and *U. reniformis* are dissimilar to seedlings of *U. cornigera*.

2. This fact excludes the possibility that *U. cornigera* could be an apomictic primary hybrid.

3. The bladderwort *U. cornigera* is the most vigorous species of the three named bladderworts, but no heterosis could survive in many generations of the sexually multiplying bladderwort. That is why it can hardly be a stabilized hybrid of much smaller parents.

Acknowledgement: I wish to thank Professor R. J. Válka Alves, University Federal do Rio de Janeiro, for his helpful suggestions.

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DIFFERENT WING IN PITCHERS OF THE MYRMECOPHAGOUS SPECIES *SARRACENIA MINOR* AND *S. RUBRA*

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Keywords: *Sarracenia*, ants, anatomy, hairs

Abstract: The pitcher wings of *Sarracenia minor* and *S. rubra* are compared. The vascular bundles are found to be different (2 vs 1), and the lateral indumenta are dissimilar. The dimensions of the wings, the shapes of the nectar roll, and its connection to the wing edge are also different. An interesting application of the system observed in the wing of *S. minor* was documented in station semaphores. *Sarracenia minor* is often described as a “primitive” species in the genus; evidence suggests this characterization is inaccurate.

Introduction

The hooded pitcher plant (*Sarracenia minor* Walt.) is well-known as a myrmecophagous species (Schnell 1976, 2002), but the sweet pitcher plant (*S. rubra* Walt.) is also a species preferring ants as prey (Moon *et al.* 2010). Myrmecophagy was also observed in 1920, but unpublished, by the entomologist F. M. Jones (Jones n.d.). Other species of *Sarracenia* can also trap ants, but only occasionally, under favourable conditions. *Sarracenia minor* is sympatric with *S. rubra* subsp. *rubra* (*sensu* Schnell 2002) and I am dealing with the question of whether the plants have similar adaptations to myrmecophagy.

Method

Observations were made on specimens cultivated in the Botanic Gardens of Liberec, Czech Republic (www.botanyliberec.cz), also depicted in the book *Masožravé Rostliny* (Carnivorous Plants; Studnička 2006). *Sarracenia rubra* subsp. *rubra*, *S. minor* var. *minor*, and *S. minor* var. *okefenokeensis* Schnell were used for observations. Microphotographs were made using a 160× objective lens and special 4× eyepiece for photography. All observations were made using fresh, vital material, taken from well developed pitchers during August 2011. The indumenta were studied while being backlit, to highlight subtle details.

Results

Overall pitcher structure for these species is well documented, but the different shapes of their nectar rolls should be highlighted. The pitcher mouth of *S. minor* is connected in an expedient manner with a furrow in the margin of the wing (Fig. 1).

Pitcher wings were compared using examples of 27 cm high pitchers in both species. In *S. minor* the upper part with a concave margin was 8 cm long (15.5 cm in *S. rubra*), the transitory flat part was 3 cm long (1 cm in *S. rubra*), and the lower part with a convex margin was 9 cm long (2.5 cm in *S. rubra*). However, the wing margin of *S. minor* is twice as wide as that of *S. rubra* (Figs. 2–4).

The vascular bundles of *S. minor* occur in two parallel bundles. This is unique in the genus—all the other species of *Sarracenia* have only one vascular bundle (Chrtěk *et al.* 1992). The two bundles may supply the wing margin and the nectar roll with water and chemical substances much better than a common single input. Sections across the middle and basal part of the wing demonstrated that the twin vascular bundles run through the whole wing length (Figs. 5 and 6). Nectar is produced copiously, and glistens visibly on the channel below the nectar glands; it is also detectable by taste.

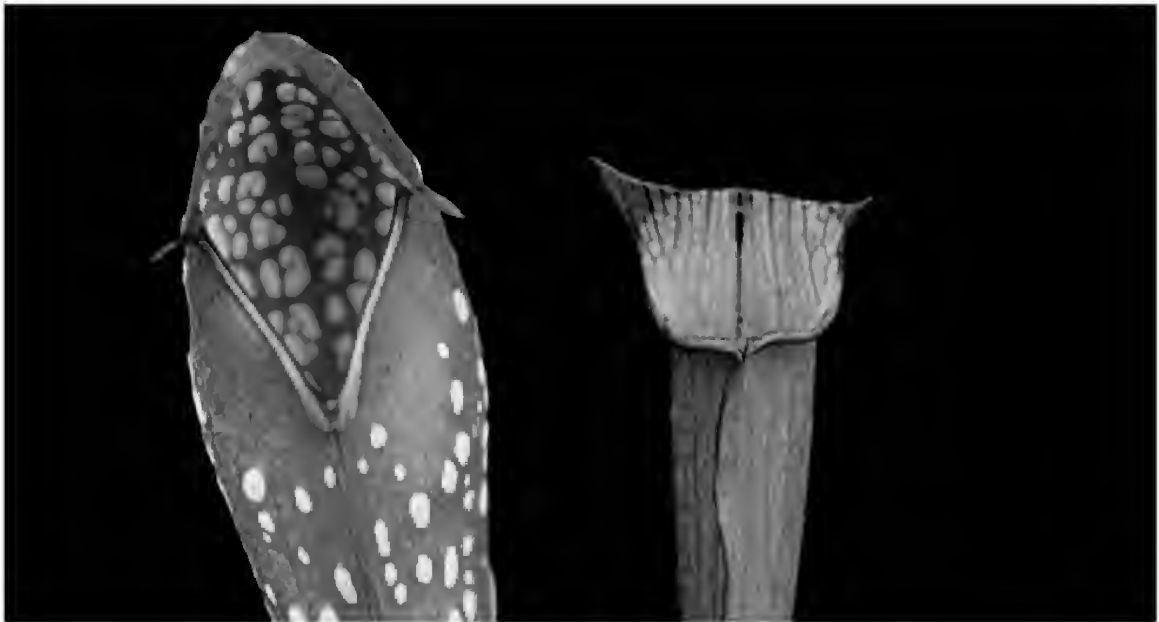


Figure 1: Different downslope of nectar rolls in *S. minor* and *S. rubra*. (Lids are cut off).

The indumentum of the wing margins of *S. rubra* is different from that of *S. minor* (Figs. 7 and 8). The indumentum in *S. rubra* is similar to other species of the genus, but hairs of *S. minor* are unique. They are parallel and bend upwards (Figs. 8 and 9). How do the hairs direct ants to the sweet pitcher nectar?

The picture examined in a microscope was vaguely familiar to me. I then followed my hunch, going to our railway station. Yes, semaphore columns were like a model of the photographed microscopic structures of the *S. minor* wing system. The hairs in Fig. 8 and the footboards or rails visible in the semaphores (Fig. 10) are similar. This is probably the answer to the question above.

Discussion

According to Schnell (2002) “many early botanists suggested that *S. minor* may be the most primitive member of the genus because the mature pitchers of this species look very much like seedling pitchers

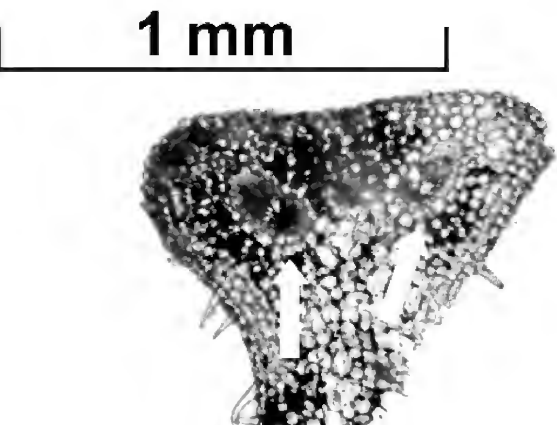


Figure 2: Transverse section through the upper part of the wing of *S. minor*, 2 cm downwards from the nectar roll. A concave edge and two vascular bundles go upwards to the nectar roll.

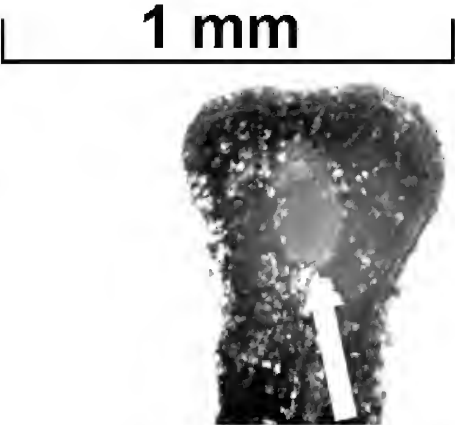


Figure 3: Transverse section through the wing margin of *S. rubra*, 2 cm downwards from the nectar roll. Single vascular bundle is conspicuous. It looks like that in other *Sarracenia* species except *S. minor*.

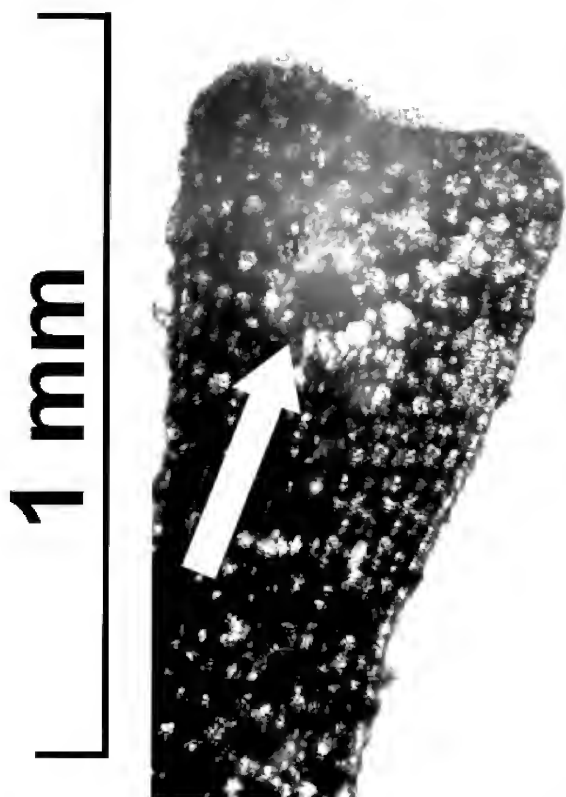


Figure 4: Transverse section through the wing margin of *S. rubra*, 4 cm downwards from the nectar roll. The margin is innervated by single vascular bundle.

of other species". If we consider the pitcher wing as connate leaf margins, the double vascular system in the wing margin documented in *S. minor* could support this idea (compare Chrtek *et al.* 1992). An interesting drawing in Lloyd (1942, plate 3, fig. 9), depicted the pair of vascular bundles close to the pitcher mouth for the first time. Nevertheless, there is an erroneous scheme of a single bundle on the prevalent part of the wing margin, the bifurcation being as far as close to the nectar roll (contrast with Figs. 2, 5, and 6). If we consider the seemingly primitive (but expedient) vascular pair together with modern signs like fenestrations and the strange specialized indumentum, we cannot regard *S. minor* as a primitive species.

Moon *et al.* (2010) also proved defensive benefits of ant luring by *S. minor*, because ants protect the plant from herbivorous caterpillars of *Exyra semicrocea*. If we put both benefits of ant presence in *S. minor* and *S. rubra* together, that is, nutrition and defense, we can also take into consideration the usual height and number of pitchers in a representative clump of either of the species. According to the pictures of natural localities (for example Schnell 1976: figs. 3-25 and 3-33), and also experience of long-term cultivation, *S. minor* has fewer major pitchers, whereas *S. rubra* has more slender pitchers. If it is true, the sympatric species probably occupy rather different ecological niches. I would be very curious as to whether anybody could compare the diversity of ant species found in pitchers of both species, especially if they grow together. Differences in quantities of various ant species shown in statistical data of populations could confirm the different niches and pertinently different life strategies and estimated cost/benefit relations.

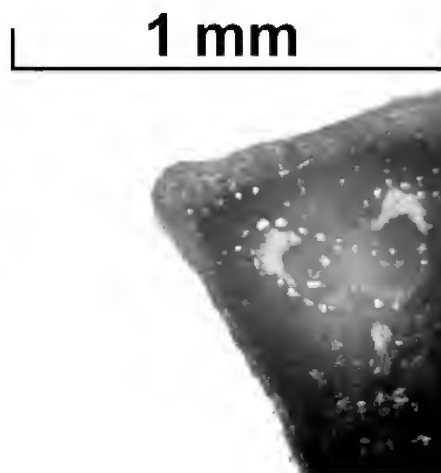


Figure 5: Transverse section through the lowest part of the wing of *S. minor*. A twin of vascular bundles supply the wing margin.

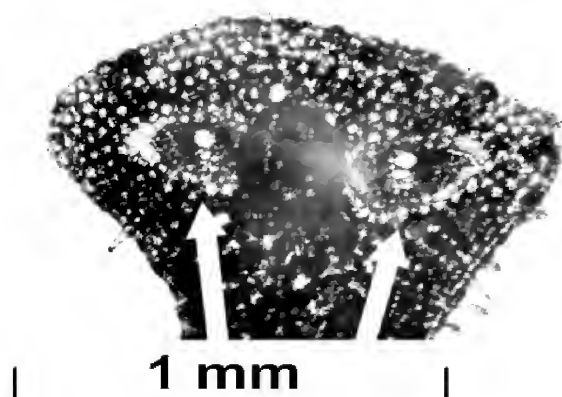


Figure 6: Transverse section through the middle part of the wing of *S. minor*, 8 cm downwards from the nectar roll. A convex edge and two vascular bundles are apparent.



Figure 7: Frontal view of the wing margin in *S. rubra*. Hairs of wing margins are straight and bristled to various directions.

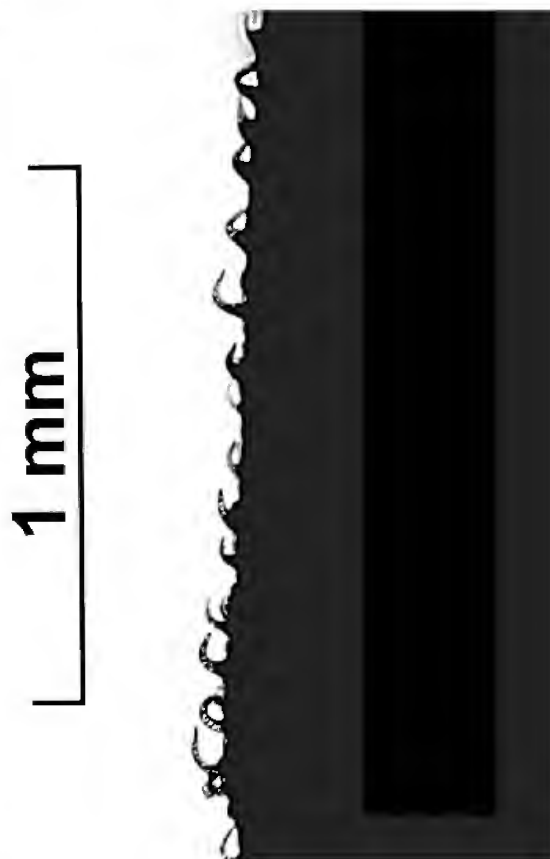


Figure 8: Frontal view of the wing margin in *S. minor*. Hairs of wing margins are hooked and pointed upwards. Such indumentum is unique within the genus.

Conclusions

1. Anatomy of pitcher wings in *Sarracenia minor* and *S. rubra* subsp. *rubra* is different, namely in the number of vascular bundles.
2. Morphology of the wings is also different, namely the concave margin, the conjunction with the nectar roll and the indumentum.
3. *S. rubra* is more comparable with other species (not specialized for myrmecophagy) than *S. minor*, which seems to be a highly specialized species.

Acknowledgement: I would like to thank Barry Rice for language editing this article.

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Figure 9: Ant's-eye view on the wing margin. The sweet path is red; the colorless hairs bent upwards are visible on the right side (the same being also on the left side, out of the picture).




Figure 10: Semaphore poles in a train station are rather similar to the observed microscopic structures of the *Sarracenia minor* wing.

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NEW CULTIVARS

Keywords: cultivar: *Sarracenia* 'Purple Velvet', *Dionaea muscipula* 'Gremlin', *Dionaea muscipula* 'Ginormous', *Nepenthes* 'The Succubus'

Sarracenia 'Purple Velvet'

Submitted: 10 December 2012

I developed a new hybrid, *Sarracenia* 'Purple Velvet', by transferring the pollen from a tall dark red *S. alata* \times *willisii* to the ovary of a *S. purpurea* subsp. *venosa*. The pollination occurred in October 2006. Six seeds were collected and sown in May 2007 and sprouted in October 2007. While two of the seedlings raised from the same ovary have similar shaped pitchers, one of the plants is veined, green in color and larger in size (Fig. 1 left), whereas the second plant, *Sarracenia* 'Purple Velvet' (Fig. 1 right), is smaller and has characteristics unique to any other *Sarracenia purpurea* hybrid I have come across. *Sarracenia* 'Purple Velvet' produces decumbent pitchers that are similar in shape to *S. purpurea* subsp. *venosa*, although these are slightly thinner, pitchers are dark purple, and the lid curves inwards. New pitchers are dark red in color, before intensifying into a dark purple color as the pitcher matures. Downward pointing hairs are present on the inner surface of the lid, as with the *S. purpurea* parent. The pitchers are currently 19 cm in height (including the lid) and 3 cm in width (6 cm across the lid). Characteristics inherited from the pollen parent include slightly thinner pitchers and their dark color. I coined the name *Sarracenia* 'Purple Velvet' on 27 January 2012 due to its intense purple color. This plant has so far not flowered, although both parent plants have the same red colored petals.

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Figure 1: Sibling of *Sarracenia* 'Purple Velvet' (left) and *Sarracenia* 'Purple Velvet' (right).

Dionaea muscipula 'Gremlin'

Submitted: 23 October 2012

Occasionally when we have been low on Venus' flytraps, we purchase them from a large wholesaler that usually puts them in horrible little capsules and sends them to the slaughter at local big

box stores. In May 2009, I found a nice all green form in one of the batches. I liked the look of it and as I didn't have an all-green flytrap in my personal collection, I brought it home and grew it outdoors with my other flytraps. By September 8, it had stuffed the pot so that the sides were bulging out (Fig. 2).

That winter I divided the plant and put it into a 30-cm bowl, which it promptly filled with plants. The next year, the plants easily filled up two such 30-cm bowls with some extra.

As I looked at the mound of plants that resulted in just a few years from a small clump, I realized that this plant was something special. Clearly this is an extremely vigorous clone that has a bizarre obsession with freely dividing and clumping. All you need to do is apply plenty of distilled water,

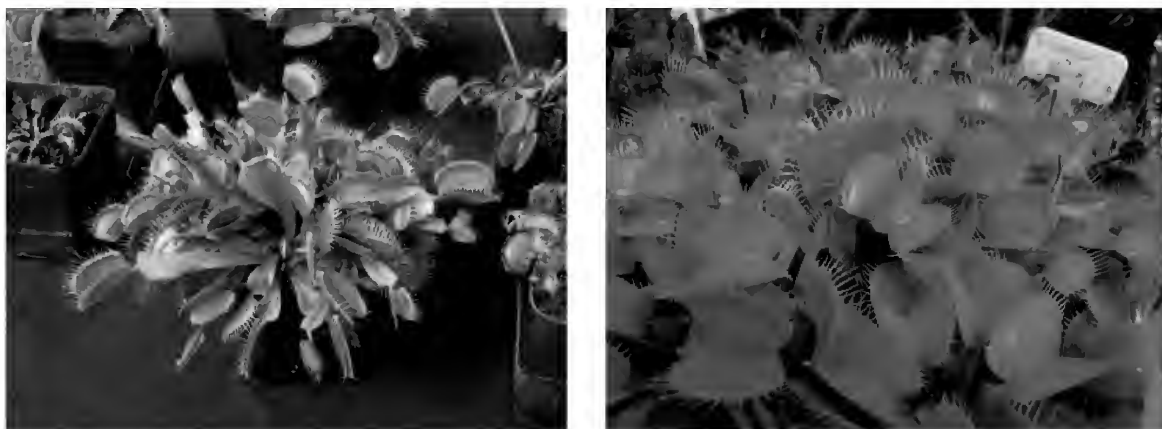


Figure 2: *Dionaea* 'Gremlin' fills a 30-cm bowl.

then sit back and watch it multiply like a gremlin. While the plant is entirely golden green, new traps may blush a very light pink when they first open in strong light. This fades away to green as they mature, but, because of this, I doubt that it is truly anthocyanin free. It can be distinguished from 'Justina Davis' by the pink blush in newly opened traps and its vigorous clumping nature.

This clone will soon be in tissue culture. We have sold a precious few in the nursery this year, but we are hoping to have many more next summer.

Warning! Do not feed after midnight...

—DAMON COLLINGSWORTH • California Carnivores • 2833 Old Gravenstein Hwy • Sebastopol, CA 95472 • Califcarn@aol.com

Dionaea muscipula 'Ginormous'

Submitted: 23 October 2012

Peter D'Amato first wrote about visiting the introduced carnivorous plant bogs at Albion, California in 1988 in his article, "A Field Trip to Mendocino" *Carniv. Pl. Newslett.* 17(1):15-19,21 and he took me there for the first time in 2005. On the long drive to Mendocino County, Peter told me of the large clump of Venus' flytraps that he had visited for years.

After we had explored the area for quite a while, Peter pointed and as my gaze followed his direction I saw the familiar white flytrap flowers sticking up out of the grass. I hurried to see it closer and was rewarded with a view of a massive flytrap clump. The traps were so huge that a few of them had even trapped little Pacific tree frogs (Fig. 3). All that remained were tiny, skeletonized shadows pressed into one side of the trap. Amazing!

This was the first “wild” flytrap that I had ever seen, so I attributed its large size to its age, habitat, and gruesome diet. Now, years later, after visiting many flytrap sites in North Carolina, I realize that it would have been the biggest flytrap in any bog.

As time went by, I visited the Albion bog almost every year to check in and take photos. Then just a few years ago, we found out that the property was owned by The Nature Conservancy (TNC), and that TNC did not appreciate the planting of non-native plants on their property. Barry Rice, then employed by TNC, participated in a removal of the flytraps along with a few other introduced carnivores, and the plants were donated to University of California, Berkeley. *Dionaea muscipula* ‘Ginormous’ is a division from that plant that used to grow in Albion.

Once, I got my hands on a piece of this old friend, I grew it outdoors at home with my other flytraps and by the end of that summer it had grown remarkably large again! Now, after growing it for a few years, I have realized that it is possibly the biggest and best flytrap cultivar so far, producing traps that rival those of the now famous and mighty *Dionaea* ‘B52’ (Fig. 3,

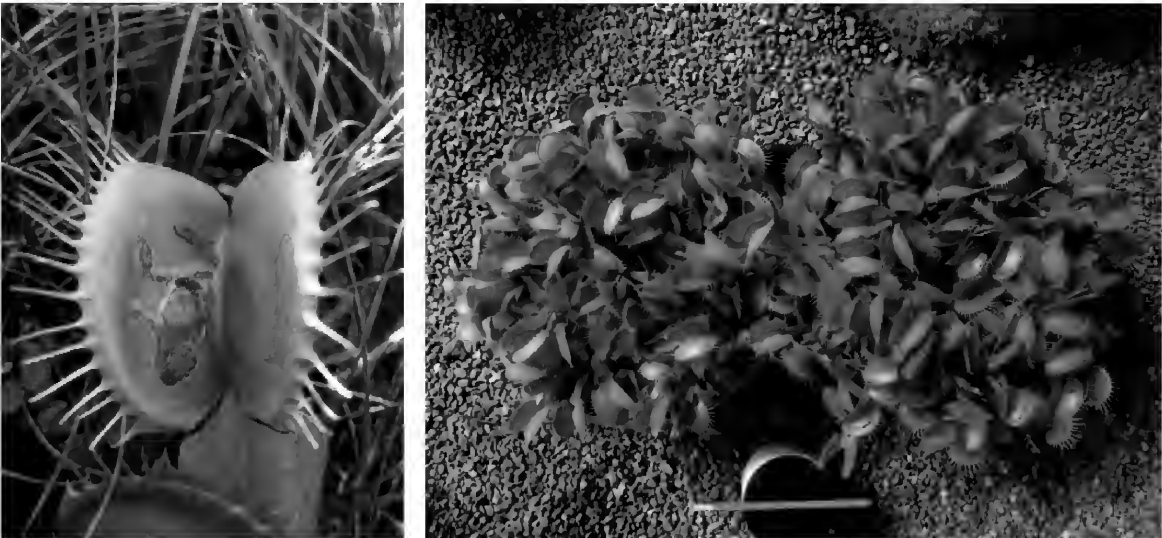


Figure 3: *Dionaea* ‘Ginormous’ with a tree frog (left) and comparison of *Dionaea* ‘B52’ (right-left) and *Dionaea* ‘Ginormous’ (right-right).

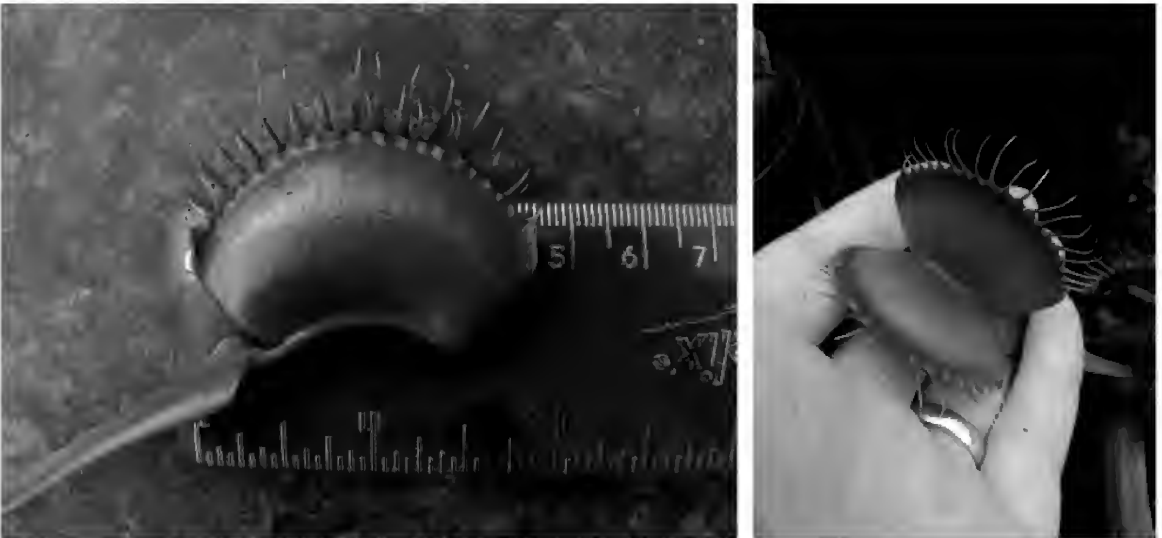


Figure 4: The traps of *Dionaea* ‘Ginormous’ can be 4.5 cm.

4, Back Cover). It seems to be slightly more vigorous than 'B52' especially when grown outdoors. It can also be distinguished from that clone because the petioles tend to be longer and the interiors of the traps are very red, but often not quite as dark red as 'B52'. I am quite sure that it is not 'B-52', as this flytrap had been there in Albion since at least 1988, long before 'B-52' was even a glimmer in Henning von Schmeling's eye.

I have asked those who originally planted carnivorous plants in the bog (who shall remain nameless) about the flytrap and no one quite remembers who put what where. It may be that this is some old unregistered clone long forgotten, but I doubt it. It seems to me that if a cultivar of this quality had been around years ago, surely it would be well known and distributed by now.

We recently introduced 'Ginormous' into tissue culture and we should have large quantities for sale exclusively at California Carnivores by summer 2013. Also, in an effort to breed ever larger traps, we have also crossed 'Ginormous' with 'B52' and the progeny already have giant traps for their age. These should be available by next spring too.

Postscript: California Carnivores would never condone feeding poor little frogs to flytraps. Frogs are our friends!

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Nepenthes 'The Succubus'

Submitted: 1 October 2012

Nepenthes 'The Succubus' is a hybrid *N. lowii* × *ventricosa* (red form) that was produced by Geoff and Andrea Mansell of Exotica Plants, Australia, and purchased as a small cutting in 2007 from Tony Paroubek at Exotic Plants Plus, USA.

The characteristics that distinguish *N.* 'The Succubus' from a somewhat similar cultivar *N.* 'Peter D'Amato' are that *N.* 'The Succubus' has exaggerated features of the pitcher mouth with a flaring peristome (Fig. 5), and larger peristome teeth with the pitcher lid consistently exhibiting numerous hairy spikes (Fig. 6) The pitcher body is squat, robust, and bulbous. The pitcher coloration is deep red, even the tendril and pitcher base are richly colored a uniform red. The upper pitchers are still quite deeply colored and have great peristome striping, with deep reds and flushed yellows.

The pitchers of *N.* 'Peter D'Amato' tend to be longer and more slender and do not have the consistent, full lid of hairy spikes nor as large peristome teeth. The parents of *N.* 'Peter D'Amato', according to The Savage Garden (D'Amato 1998 p.274), are *N. ventricosa* × *lowii*.

The female *N. lowii* × male *N. ventricosa* cross (note that the female and male parents are reversed) that produced *N.* 'The Succubus' gives this cultivar stronger *N. lowii* characteristics such as the lid spikes, peristome teeth, and more contorted features, but making it less tolerant of warm temperatures and not as fast growing. The deep coloration, numerous lid spikes and striped peristome, even on the upper pitchers, are all distinguishing characteristics that set this individual apart from other *N. lowii* × *ventricosa* hybrids.

Also, the plant grows large like *N. lowii*, compact like *N. ventricosa*, and produces pitchers frequently, making it a great indoor specimen (Fig. 7). It grows well in warm temperatures, but exhibits the best characteristics in cooler temperatures akin to the *N. lowii* parent.

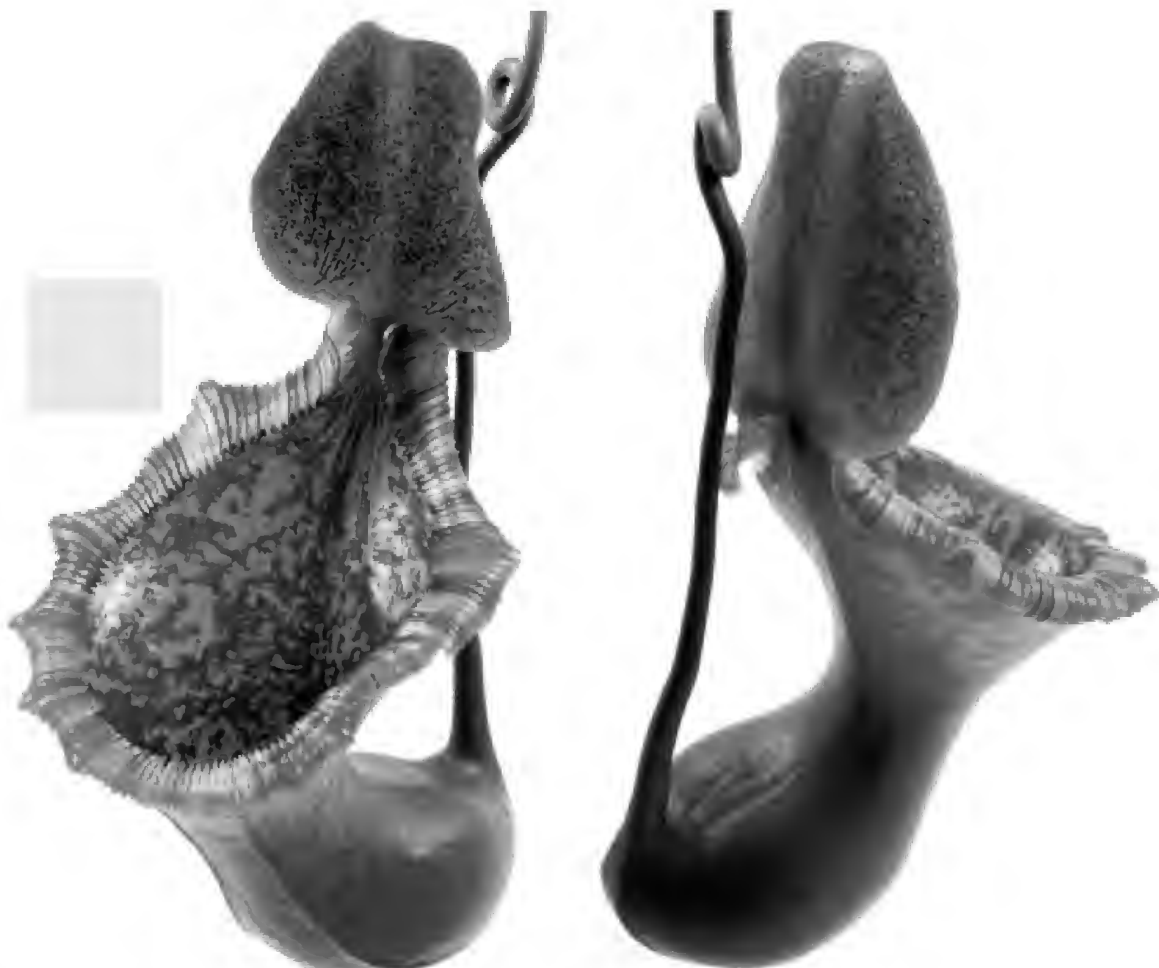


Figure 5: *Nepenthes* 'The Succubus' pitcher.

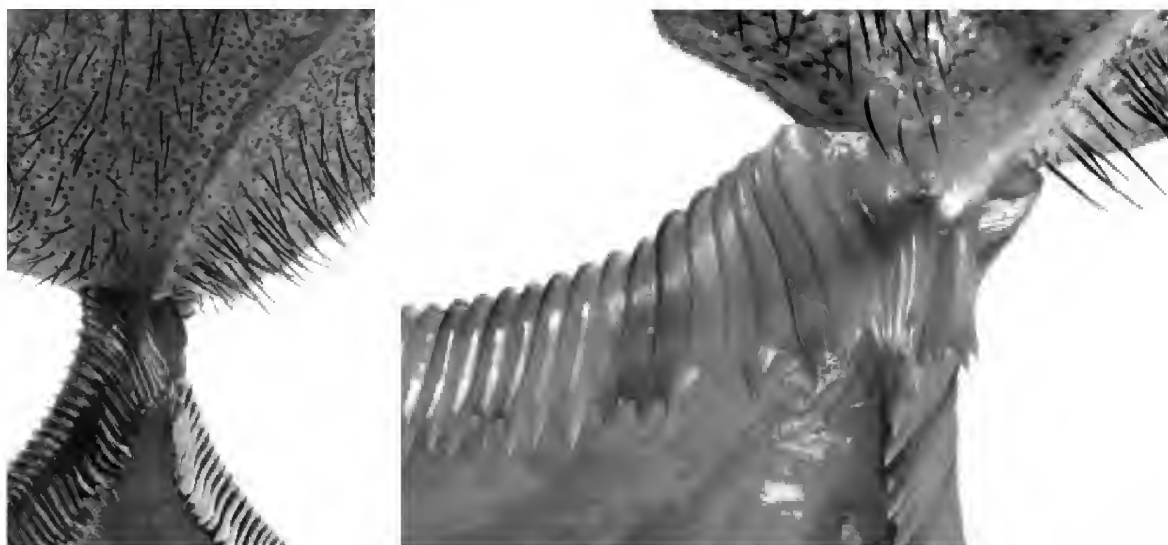


Figure 6: *Nepenthes* 'The Succubus' lid with numerous hairs (left) and peristome teeth (right).

The plant has flowered and is a female.
 This plant was awarded Juried Best-in-Show at the 2012 ICPS Conference and Best-in-Show at the 2010 NECPS Exhibition.



Figure 7: *Nepenthes* 'The Succubus' plant.

I named this plant *N. 'The Succubus'* in July 2012 because it is so deeply colored blood red, has such wicked characteristics, and with the constricted waist giving it a feminine, vampish appearance. The plant has an entrancing and demonic quality, and as it is a female, the name is particularly fitting.

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DROSERA ANGLICA IN ALASKA

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For years I have been interested in the native carnivorous plants of Alaska. In particular the sundews have held my continued fascination. I grew up with my grandmother's stories of "purple people eater" sightings—her name for sundews that grew in the bogs around our family cabin on the Kenai Peninsula.

Little has been written about carnivorous plants in Alaska. Typically the literature has been limited to brief descriptions found in flora guidebooks (Pratt 1991, 1993; Schaffer 2000), or a brief description of species and range (Hulten 1968; Schnell 2002). There are two sundews native to Alaska, *Drosera rotundifolia* and *D. anglica*. *D. rotundifolia* has been recorded from all across Alaska, while the literature on the distribution of *D. anglica* hasn't been quite as clearly defined. Schnell's (2002) range map shows a narrow distribution of *D. anglica* in Alaska limited to Kodiak Island in Southcentral Alaska. It is shown in neighboring British Columbia, so it is conceivable that it could be in Southeast Alaska as well. Hulten (1968) showed a greater distribution of locations across the state.

It is not surprising that there are differences in published ranges, with additional sites beyond what is typically shown. Alaska is a large state. The road system is very limited in Alaska, and much of Alaska can only be easily reached by small plane or boat during a brief summer growing season. As a result, many parts of the state are botanically under explored.

Over the past several years I have explored a number of bogs in Southcentral Alaska and have found *D. rotundifolia* galore! However, until recently, I have been unsuccessful in finding *D. anglica*. To help narrow my search for this little beauty, I searched the University of Alaska Museum of the North Herbarium (ALA) for any specific locality data. A search of the herbarium data base (accessed 7 January 2013) listed 79 records for *D. anglica* in Alaska, of which 64 had specific local-



Figure 1: Distribution of *Drosera anglica* in Alaska based on specimen data in the University of Alaska Museum of the North Herbarium (ALA). Map generated from herbarium data by Berkeley Mapper using Google Maps.

ity data. As can be seen from Fig. 1, *D. anglica* is broadly distributed in Alaska. As more remote locations are explored, I have great confidence in further range extension.

The herbarium data helped confirm that historically there have been populations of *D. anglica* on the Kenai Peninsula where I tend to spend time bog hopping looking for carnivorous plants. Encouraged by this, my efforts were rewarded this past summer on a bog hopping field trip where I finally found a healthy population of *D. anglica*!

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Figure 2: *Drosera anglica* from a Kenai Peninsula bog during the summer of 2012. Photograph by Mike Baldwin.

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